R & M COSTS OF LOGGING MACHINERY

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INTRODUCTION

The initial brief for this paper as provided by Mr Vaughan of LIRA was to present rules of thumb for the expected lives and costs of commonly used types of logging equipment. While the following may provide these figures it should be realised that they only apply to N.Z. Forest Products Limited and should not be used directly by other equipment owners and operators without allowance for different cost structures and accounting systems.

The information which can be used, however, are the actual parameters of measurement and the use to which they can be put for cost control and replacement decisions. The actual value of each parameter should be determined for a particular operation by experience and from accurate records.

The end result of these different factors are the use they can be put to in determining:-

(1) Machine specifications
(2) Correct Operating procedures
(3) Costs for budget purposes and contract rates
(4) Costs of abuse or poor maintenance
(5) Economic life and planning for reubild or replacement.

VEHICLE COSTS

An owner of a vehicle or piece of logging equipment can expect to have costs related to:

1. Standing or ownership costs
2. Tyre costs
3. Fuel and oil costs
4. Routine servicing (filters, greasing etc)
5. Repairs and maintenance.

Standing costs are annual fixed ownership costs and reflect the difference in market value at the beginning and end of each year. Accountants may use different schedules in depreciating the cost of a machine but the reality is the cash that is foregone by using the machine for another year instead of selling it.

Servicing, fuel and tyre costs are expected to be proportional to the distance travelled or hours of operation and are relatively independent of workshop efficiency.

R & M on the other hand, will be the cost area with the largest potential for variation and also the least predictable due to the influences of workshop efficiency, operator ability, operating conditions and machine age and specification. As a variable cost dependent upon some of the above factors it has the greatest potential for reduction and is therefore the cost area with the greatest effect upon machine profitability.

R & M COSTS

These costs are the sum of the labour and spare parts charges that are required in the maintenance of a machine to keep it in a workable condition. It is important that identifiable accident and abuse related costs are extracted prior to any analysis so that the R & M can be considered an indicator of the ability of a machine to do a job. This consideration allows owners to compare operators, different machines doing like jobs and also the reduction in net earnings of the machine as deterioration and wear occurs due to age. When this latter fact is considered in conjunction with the reducing cost of ownership with age, an idea of the time of machine replacement or rebuild can be determined.

To have the ability to carry out the above functions there must exist for every machine a comprehensive history of the repairs that have been carried out, the machine age that they were done and the cost of those repairs. While it may seem fruitless to some to spend time compiling records on money already spent it is suggested that unless this is done and the results analysed periodically there can be no basis for sound decision making on future operations.

The use of historic costs to provide this basis for prediction has been criticised by some who instead tend to utilise "average" values from "average" operators. Obviously if no records exist, or the records can not be relied upon to be accurate then average values are the only basis upon which decisions can be made. If however factual historic R & M costs and information trends for individual machines is used in conjunction with an intimate knowledge of existing machine condition then this must form a much more accurate and reliable method of predicting future occurrences for your machines. This is in fact the key assumption in the use of any R & M cost records - i.e. historical data provides the best means of determining the operating cost of an existing machine in the future as well as a new machine operating under the same conditions.

It should not be expected that machines will follow a perfect statistical curve throughout their lives, conditions change, usage varies and the input of maintenance is not constant. However, the above can be allowed for when measuring the costs against pre-determined benchmarks and adjustments made to suit.

R & M REPORTS

R & M reports should be studied on a monthly, year-to-date and life-to-date basis, each has its own importance in relation to different factors.

1. MONTHLY REPORT

This report may take the form of an invoice for repairs from a maintenance workshop or possibly, in larger organisations, a computer tabulated report. The purpose of this report is simply to see what was spent during the month, to check on workshop operations and efficiency and to ensure that no excessive charges have been made. Performance in relation to budget is also easily obtainable although little other data can be gainfully utilised as the money has already been spent.

2. YEAR-TO-DATE

This report is an accumulation of the year-to-date monthly information, the major use of which is to determine short term trends in cost. e.g. why have three turbos been fitted during the last three months? Why have we had to carry out transmission repairs twice in the last two months? etc.

From this data action can be taken to rectify any problems that may have been identified from the report - be they operator or mechanically oriented.

Ideally these reports will break down the total cost into cost areas within a machine i.e. separate codings for front axle steering, engine, clutch etc and the costs allocated to these areas will allow analysis for determining component performance. This has a major influence when re-speccing future equipment. Refer Appendix 1.

3. LIFE-TO-DATE REPORT

This report serves a similar function to the year-to-date tabulation but for longer life components such as engines, final drives, tracks etc. Perhaps however the most important function is for use in vehicle replacement decisions. Firstly to determine economic life, secondly to evaluate options such as second-hand machine purchase, rebuild or replacement and finally to determine specifications.

The point being that R & M costs and records are of importance, not so much in what the machine is costing now but more importantly what its anticipated future cost will be compared to the alternatives of replacement, rebuild etc.

Once again, a breakdown of the total cost into component costs is used to indicate problem areas that require identification and solution. This solution will, of course, often take the form of reassessing future machine specifications or manufacturer.

Appendix 2 demonstrates some of the operating data for a selection of logging equipment and the component costs. These figures, when compared to benchmarks, may indicate problem areas that require the attention mentioned above.

The data provided by this report allows calculation of various parameters that have their ultimate use in the vehicle replacement decision. The most important figure to extract is the cumulative maintenance cost per total machine operating hour. Many people talk of the operating cost for a month or for a year but these figures have little relevance except to eventually provide the life-to-date cost per total machine hour or kilometre. That is, a high cost per hour on a monthly basis is saying that an engine failed within the month and a high cost incurred accordingly. In actual fact the engine had been progressing toward the ultimate failure on a gradual basis ever since being first started as a new piece of equipment. The cost of that engine on a per hour or per km basis should therefore be considered over the period of life at failure. For example, over a six year life a tractor may have an annual m't'ce cost of $8.70 per hour, $11.92/hr, $17.50/hr, $16.82/hr, $11.25/hr and $9.54/hr with a cumulative R & M cost over the six year life of $12.26/hr. The yearly figure rises and falls as varying degrees of work are required. The meaningful figure of course is the life-to-date figures of $12.26/hr.

REPLACEMENT

The ultimate use of any set of R & M cost records is for the determination of machine life. Every machine has two lives - a physical life and an economic life. The first is engineering related and is probably based on the period of time during which spares can be obtained, that is, in some cases maybe twenty to thirty years. At this point the machine will usually be abandoned or scrapped. A machine can be run this long and a lot of people do just that - but not economically, to say the least.

The second life is the economic life which is the period that the machine has the lowest total cost compared with any similar machine. As soon as it can be shown that another machine which may be second-hand, rebuilt or new has a lower total annual cost, then the economic life has been spent.

Obviously the problem is to determine the point at which this economic life will be reached. Intuition is by far the most popular method. Often machines are replaced when they require a major repair, at other times when a new job is started. At other times when the capital reserve has built up to such a stage that the replacement can be made. None of these decisions has a sound economic base to be used as a criterion for a planned programme of replacement. As stated a number of times previously, proper replacement timing depends on a prediction of future costs which can only be determined by analysis and early extrapolation of an accurate record of past costs.

Once the recording system is arranged to produce the required output the prediction on replacement timing can be made. This point will occur at the economic life, which, stated again is the point which yields the minimum total cost per hour taken over the entire life of the machine. If replacement is made prematurely, costs of ownership will be higher than necessary. If replacement is late, costs of maintenance and downtime will be excessive.

For a new model of machinery the actual R & M trends can generally be established after one to two years and projected into the future using estimates of expected maintenance. For new machines that are already represented within a fleet by either similar or identical units the estimates of maintenance will obviously be more accurate and if sufficient experience with a particular model has been gained the replacement date may be set even before the machine is delivered by the distributor.

The replacement decision is now seen to be based on the interaction between increasing R & M costs with age and reducing ownership costs with age. This latter cost may be calculated simply as the cost of reducing market value as the machine ages.

In actual fact the utopia of determining exact replacement times is altered by the reality of such factors as capital availability, delivery lead time or simple indecision. While the foregoing are unfortunate facts of life for all machinery owners which seem to increase directly in proportion to the inflation rate, if an economic life is established early enough the major problems above may be reduced. In any case, at least the increasing cost of machine retention past its economic life can be demonstrated which in itself provides justification for adhering to the arithmetic.

SUMMARY

Although having demonstrated the basis upon which replacement and operating costs should be accumulated, analysed and utilised it is obvious to the reader and probably even more obvious to a machine owner who has undergone the rigours of the analysis that the final answer is not easy. Where sums of 200 to $300,000 or more may be involved it is the writers belief that these decisions must be made with the involvement of professional people, who can ensure that replacement decisions are soundly based and make economic sense. To apply a rule of thumb, developed by someone else to varying conditions could indicate totally incorrect options. The cost of maintenance varies widely between applications so that the correct decision must depend on data drawn from each specific operation. This decision depends on accurate record keeping which predicts future operating costs of both old and new machinery and comparing those costs over the proper period of time.

APPENDIX 1

For detailed analysis of R & M costs the total machine should be divided into components and the relevant costs allotted to each. Major components such as the engine, for example, may be further sub-divided into say water pump, compressor, heads etc which provides an owner with an even more detailed opportunity to pinpoint problem areas but this is at each owners option.

Codings used by N.Z. Forest Products Limited, Garage Division, are listed below:

R & M Codes

1	Front Axle
2	Steering
3	Motor
4	Clutch
5	Main Transmission
6	Aux. Transmission
7	Mid Axle
8	Rear Axle
9	Brakes
10	Chassis and Body
11	Hyd. System and/or Hoist
12	Track Gear
13	Winch
14	Blade and/or Bucket
15	Boom and/or Hoist Frame
16	Electrical
17	Logging Equipment
18	Ancillary Equipment
32	Checks W.O.F. etc Inspection

APPENDIX 2

LIFE TO DATE COSTS BY COMPONENT CODE AS A PERCENTAGE OF TOTAL R & M FOR A SELECTION OF COMMON LOGGING MACHINERY

MAKE & MODEL \ CODE:	1	2	3	4	5	8	9	10	11	12	13	14	15	16	18	32
Crawler A	-	-	12.5	-	5.1	-	1.3	7.9	5.45	44.7	10.9	6.8	-	2.07	1	1
Crawler B	-	-	19.8	-	7.5	-	1.3	9	5.7	30.3	6.1	9.1	-	6.8	1.3	1.2
Crawler C	-	-	20.2	-	8.3		2.1	5.5	1.6	36	4.9	15.4	-	4	1.1	-
Wheel Loader	2.5	2.6	15	-	5.4		5.7	11	19.5	-	-	8.4	11.3	10.3	6.3	1.1
Logging Crane	-	-	11.8	7	12.6		5.3	13.7	15.7				9.5	5.3	17	2.2

An experienced owner can utilise the above figures for comparison purposes between machine types allowing for any different operating conditions. His analysis could effect the decision on machine purchase or perhaps to ensure that the franchise holder investigates why a component has a low service life. e.g. an obvious question from the figures above is why the code 3 (engine) cost on crawler A is 40% lower than either B or C and care must be taken before conclusions are drawn - are the hours lower? Are the operating conditions different?

APPENDIX 3

As an actual example of an R & M replacement problem consider the case of a logging truck purchased in 1980. R & M records kept since delivery provide the following, inflation adjusted data:

	1980	1981
R & M	$2,681	$8,441
Km	35,491	53,442

A close knowledge of this particular brand of truck and specification allows us to estimate expected costs in 1982, 1983, 1984 etc. A similar knowledge of projected logging determines the estimates of kilometres for the same periods. This leads to the following tabulation:

	1980	1981	1982	1983	1984	1985	
R & M	$2,681	$8,441	$14,000	$19,172	$22,397	$29,553	
Km	35,491	53,442	53,000	53,000	53,000	53,000	
LTD*R & M	$2,681	$11,122	$25,122	$44,834	$67,231	$96,784	
LTD km	35,491	88,933	141,933	194,933	247,933	300,933	
LTD $\frac{R\ \&\ M}{km}$	0.075	0.125	0.177	0.230	0.271	0.321	- (1)

Ownership costs are estimated on a 20% loss in value per year for ease of calculation, however a more correct method would be the use of appropriate market values.

	1980	1981	1982	1983	1984	1985	
Ownership costs	$23,990	$19,192	$15,353	$12,282	$ 9,826	$ 7,861	
LTD Ownership costs	$23,990	$43,182	$58,535	$70,817	$80,643	$88,504	
LTD $\frac{Ownership}{km}$	0.676	0.485	0.412	0.363	0.325	0.294	- (2)

Economic life has been defined as the period which yields the minimum total cost per hour or km over the entire life of the machine. The total cost is therefore the sum of (1) and (2).

	1980	1981	1982	1983	1984	1985
LTD R&M/Km	0.075	0.125	0.177	0.230	0.271	0.321
LTD $\frac{Ownership}{km}$	0.676	0.485	0.412	0.363	0.325	0.294
Total $/km	0.751	0.610	0.589 ↑	0.593	0.596	0.615

The period for economic replacement for this truck operating under this system is therefore at the beginning of the fourth year when the total operating cost per km is at a minimum. The solution is shown graphically on the next page.

Note that a recalculation with a five percent reduction in R & M would indicate a retention for another year, so that the minimum total cost would occur in 1983 and drop from $0.589/km to $0.579/km.

*Life to Date

GORMACK GRAPH PAPERS : CHRISTCHURCH N.Z. B101Y 10ths, ½ & 1 inch

CUMULATIVE COSTS PER KM